Machinery Messages

Case History

Continuous Improvement Process helps company remain competitive

"The empowered team of Mechanical Maintenance will provide, with pride, environmentally-sound, safe and reliable service meeting our customers' requirements. We will apply Continuous Improvement to achieve a leadership role in accomplishing the business goals of the Whitney Canyon Operations Center."

Mission Statement
Whitney Canyon Mechanical Maintenance

by Pat D'Esposito Jr.
Senior Sales Engineer
Bently Nevada Corporation

This article describes how Amoco Production Company uses Trendmaster®2000 to maintain a high level of safety, accurate data and reduced maintenance costs at three gas production facilities. Trendmaster®2000 is a computer-based system which automatically samples, processes and trends data from large numbers of machines to provide timely and accurate data on machinery condition.

Amoco Production Company constantly searches for ways to become more cost-efficient. To achieve this efficiency, they developed their Continuous Improvement Process (CI) in the late 1980s and fully implemented it in the early 1990s. CI requires participation at all levels, from the Chief Executive to plant personnel. As part of this process, Amoco personnel identified and researched emerging technologies which would provide immediate payback in terms of improved safety, decreased expenditures and increased production. In 1991, the Centralized Maintenance (CM) team of Amoco Production's Northwest United States Business Unit Evanston (Wyoming) Operations began investigating Bently Nevada's Trendmaster® 2000 System.

The Evanston Operations include three separate gas production plants (Whitney Canyon, Painter Reservoir and Anschutz Ranch East), with a total output of approximately 1000 million cubic feet (28 million cubic meters) of gas per day. Art MacLean, CM Foreman at the time, explains how the selection process worked. "In 1991, we began bringing in a number of vendors' new on-line systems for evaluation on actual machines. The live testing allowed us to verify real performance, not brochure promises. Some systems didn't live up to the literature.

"We could then develop expectations and start eliminating systems. None of the systems (other vendors) did what Trendmaster® 2000 did." Amoco Production used Trendmaster 2000 as an integrated tool in their Maintenance programs at all three of their Wyoming facilities. "The vision wasn't just tying in three separate plant systems into a central location. The vision was having information immediately available for the entire business unit. We have a wide range of processes, and plants do things differently. We needed a way of easily getting information on the plants and making comparisons to determine the optimum [conditions] for operating the plants."

Randy Moore, Senior Mechanical Field Technician, was also involved in this investigative phase. Randy adds, "Our biggest task as a central group was to research technology, to apply technology and to keep leading edge technology in place. The Trendmaster® 2000 System was leading edge then for non-critical equipment." He describes Trendmaster 2000 as a nice fit in terms of utilizing manpower better, more efficiently. "Having ten people collecting data translates into recurring costs for people to do what computers and probes can do quicker and more accurately. With [the data collection automated], Amoco personnel can devote more time to troublesome pieces of equipment. Trendmaster 2000 is one of the few things I saw that would really have an impact on our business."

Roger Bargar, Central Maintenance Production Foreman, adds that systems like Bently Nevada's Trendmaster 2000 address Amoco Production's concerns in three main areas: compliance and mechanical integrity issues, safety issues and budgetary issues. He thinks such systems can provide both the information they need to maintain production goals and high levels of safety. Bargar believes Trendmaster 2000 can provide early warning of possible machinery problems. "The system is a prime example of something that gives you a warning before it becomes a major problem," states Bargar. He also sees it as a real labor saver. As he puts it, " .. all industries are in some kind of budgetary restraints and need to cut back and do more with less. These types of systems have proven to be invaluable tools for us. We can plan ahead and be much more efficient."

Precision Maintenance as a part of CI

According to Mack Morris, Mechanical Maintenance Foreman at the Whitney Canyon Plant, "Continuous Improvement involves stages. First, you have to

be able to measure performance effectively. After you measure performance, you can begin to manage it. After you can manage it, you can look to improve performance. We are measuring now with Trendmaster 2000, looking at our equipment run time. From this, we'll be able to manage our machines. Later we look to improve." Morris also explained that, as part of CI, Whitney Canyon has implemented a Precision Maintenance Program. He describes Precision Maintenance as an investment program. More time and money is spent initially on machine repairs, such as balancing and achieving tighter tolerances, and on cost-effective machinery monitoring. As Mack puts it, "We hope that the additional money spent upfront will add months, or even years, to the run time of equipment." The Whitney Canyon plant has approximately 1500 pieces of equipment, which translates into a tremendous amount of horsepower. Mack says industry studies have shown that a Preventive Maintenance Program will cost you about $11-$13 per horsepower and that a Predictive Maintenance Program can reduce this to about $7-$9 per horsepower. Amoco Production's immediate goal is to reduce these costs to the $4-$5 per horsepower range.

Future plans include benchmarking

Amoco's use of Continuous Improvement in every aspect of their work fits with their proactive approach toward maintenance. According to Bargar, "Task skill-building will take some time, but our intention as a business unit is to build a quality maintenance program from the base up, guided by Continuous Improvement methods and tools."

Amoco Production is also in the process of benchmarking their operations with other gas producing companies. Officials from other companies are brought in for shared discussions on operation and maintenance philosophies. The goal of this program is to compare which programs, systems and products work and which don't. Amoco Production is constantly striving to be "the premier oil & gas company." ►

Whitney Canyon Gas Processing Plant

Painter Reservoir Complex Gas Processing Plant

Anschutz Ranch East Gas Processing Plant

Trendmaster®2000 information in the control room helps operators manage Whitney Canyon's machinery.

Whitney Canyon

Amoco Production's Whitney Canyon Gas Processing Plant is located 23 miles (37 km) northeast of Evanston at an elevation of 8000 feet (2400 m). The gas field was discovered in 1977, plant construction began in 1980 and was completed in 1981. Average daily throughput at this plant is approximately 135 million cubic feet (3.8 million cubic meters) of gas, 2000 barrels of condensates, 4000 barrels of natural gas liquids and 800 long tons (812,800 kgs) of sulfur.

In 1992, Whitney Canyon began an aggressive program to implement new technology to improve their operation. Bently Nevada's Trendmaster 2000 was one of the products that was identified as a solution to significant business problems.

To maintain their competitiveness, Amoco had to work smarter. One of the tasks they examined was data collection. Management at Whitney Canyon supported the argument that a one-time, capital expenditure, amortized over a period of time, was beneficial if it allowed them to contain the rising cost of maintenance, a recurring expense.

Mel Wren, Production Operator, states that, before commissioning the Trendmaster 2000 System, Whitney Canyon was spending approximately 35 manhours per week collecting data from their essential (weekly) and general-purpose (monthly) machines. After commissioning the Trendmaster 2000 on their essential machines, the manual data collection time has dropped to about 15 hours per week. Mel adds that the Trendmaster 2000 has also helped reduce overtime costs since data collection on their essential machines is now automated.

In addition to the manpower issue, costs associated with lost production are critical at Whitney Canyon. According to Mack Morris, not meeting customer demand due to unplanned downtime results in lost revenue of about $230 US Dollars per minute to Amoco Production. When you're talking about hours or days to fix an unplanned or unidentified problem, that translates into big money. Whitney Canyon is aggressively using Continuous Improvement tools to solve these problems.

System installation

Whitney Canyon's Trendmaster 2000 was installed and on-line by April 1993. The initial 210-point system was installed on machines in their Compressor, Sulfur and Amine plants. Phil Van Grinsven (Central Maintenance) designed and commissioned the system installation. A walkthrough of the plant was done with Bently Nevada field personnel to prioritize all machines for safety, production, and environmental concerns. Once this was done, machine locations were mapped on a plant layout. Wiring routes were laid out, based on the location and the information required from the machine. Hardware and software needs were then determined.

The installation of the intrinsically-safe Trendmaster 2000 System required the cooperation and support of all of Whitney Canyon's departments. Working together, they installed their Trendmaster 2000 quickly, using suggestions from plant personnel that saved time and money. One particular suggestion was to use UNISTRUT for transducer cable routing by machines. Figures 1 & 2 provide some illustration of this innovative installation design. Using UNISTRUT, instead of conduit, for these cable runs, helped reduce Whitney Canyon's installation costs while still providing for a safe and clean installation.

The intrinsic safety aspect of Trendmaster 2000 was a key factor for Whitney Canyon when choosing a system. As Marlin "Barney" Barnes put it, "The best thing about the installation was the intrinsically-safe aspect. In a gas

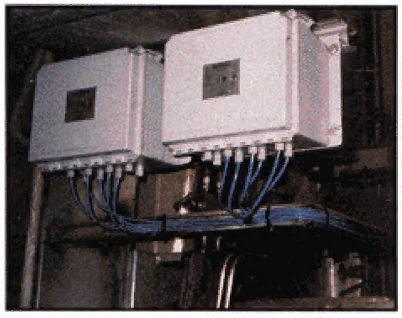


Figure 1

Figure 2

Amoco ran Trendmaster®2000 cable in UNISTRUT for a neater, more cost-effective installation.

"Having ten people collecting data translates into recurring costs for people to do what computers and probes can do quicker and more accurately ...Trendmaster® 2000 is one of the few things I saw that would really have an impact on our business."

Randy Moore
Senior Mechanical Analyst

plant, you don't want any sparks, any possibility of an ignition source. The Trendmaster 2000 can be run in an open environment [without being in conduit or having purged systems]." Whitney Canyon personnel were impressed with how easy it was to configure the Trendmaster 2000 System Software.

Machinery management philosophy

Whitney Canyon's Machinery Management Program is a team approach involving both operators and maintenance personnel. The plant's control room has a display terminal to let operators know when a possible problem has been found. The on-line Trendmaster 2000 System enables Whitney Canyon to better manage equipment upsets and run time, due to early detection of problems. This is a new tool they didn't previously have. To do so manually would have involved massive resources devoted to data collection.

When operators notice an alarm condition, they look at the data. Typically, a vibration technician is called in for consultation. If required, Central Maintenance personnel can access the system data through remote (modem) communications to add their suggestions. If more information is needed, portable instruments can be used to collect additional data. At Amoco, decisions are usually made as a group on whether to continue running, switch to spare or shut down the unit. Information, such as historical trends, process conditions and process changes, is used to determine the cause and severity of the problem.

Group problem solving is a typical process at Whitney Canyon. Continuous Improvement teams meet often to solve problems. Identified problems are brought up and possible solutions are discussed. One or many of the solutions are implemented, end results are measured and teams meet again to review the decision. Continuously improving their process is a daily function at Whitney Canyon.

Benefits received

Documentation of the benefits received from implementing new technology through the Continuous Improvement Process is a vital component. Between April and October 1993, Whitney Canyon documented nine machinery incidents involving machines included on their Trendmaster 2000 System. Table 1 outlines these machine incidents and compares possible catastrophic costs (run-to-failure) versus actual repair costs by using the Trendmaster 2000. Whitney Canyon has documented over $500,000 USD in maintenance repair cost savings alone in the last six months! To Amoco Production, that translated into payback of the original system cost in a little over one month!

These figures do not include the additional savings realized in avoiding possible plant downtime (production losses) and labor (maintenance costs, overtime). Machinery availability is also improving. For the last quarter, machine availability at Whitney Canyon was at 99%. Based on these successes, Whitney Canyon's Operations and Mechanical Maintenance teams are convinced that Trendmaster 2000 is helping them identify problems before they become catastrophic. This allows them to plan for repair or replacement in an organized and efficient manner. The bottom line is that implementation of new, field-proven technology, such as Bently Nevada's Trendmaster 2000, is proving that Amoco Production's Continuous Improvement Process is working.

Trendmaster® 2000 has allowed Whitney Canyon to react more quickly and efficiently when a possible problem arises. In the past, reacting to an unidentified machine problem often required using 3 to 4 people immediately to switch to spare equipment. The problem machine would need to be isolated, bled down and purged, and opened up. This was extremely costly, especially if overtime was required. This cost would really multiply if the problem forced the process to go to flare (production loss). "Now," adds Mack Morris, Maintenance►

Phil Van Grinsven points out how standalone continuous monitoring racks are interfaced into Amoco's Trendmaster®2000 System.

Foreman, "It's a controlled change from one pump to another because of what Trendmaster 2000 provides us. It helps to keep us out of difficult operating scenarios. It saves us downtime and lost production. It's a very important tool for us. It does more than just monitor vibration."

Whitney Canyon credits Trendmaster 2000 in helping them to keep the process going. The system is helping them to "stay in the pipeline," while meeting the safety, environmental and revenue goals of their business.

Future plans

Whitney Canyon recently implemented a Comprehensive Maintenance Management software program to help track maintenance records and costs. This will let them easily retrieve a machine's maintenance history and year-to-date costs. Operations management quickly realized the benefits of this system. They plan to integrate Operator training on the Trendmaster 2000 as part of their 1994 goals.

Whitney Canyon also plans to implement a Total Planned Quality Maintenance program. They believe that this, in conjunction with Continuous Improvement, could result in yearly savings in maintenance costs of approximately 10%.

Whitney Canyon has documented over $500,000 USD in maintenance repair cost savings alone in the last six months! To Amoco Production, that translated into payback of the original system cost in a little over one month!

Painter Reservoir Complex

The Painter Reservoir Complex Gas Processing Plant is located 7 miles (11 km) northeast of Evanston, Wyoming. The gas field was discovered in 1976-77, plant construction began in 1986 and was completed in September 1987. Average daily throughput at this plant is approximately 215 million cubic feet (6 million cubic meters) of gas, 1000 barrels of condensate, 9,500 barrels of natural gas liquids and 100 million cubic feet (2.8 million cubic metres) of hydrocarbon gas. This 24-hour, 7-day-per-week plant is operated under a partnership between Amoco Production, Chevron and Union Pacific Resources.

In early 1992, Painter experienced some costly problems with their Natural Gas Liquids (NGL) pumps and associated piping. Machinery and structural vibrations were causing production problems and possible safety hazards. Severe vibration broke off valves and pipe nipples and caused tubing to crack. More importantly, these valves were on pumps located in a Class I, Division 1 rated area. They decided to implement a combination of solutions, including adding desurgers to the line, reclamping the lines and increasing monitoring of the area. They decided to automate data collection.

Painter was the first of the three Amoco Production gas plants to install and use a Trendmaster 2000 System. Their initial system was commissioned in Fall 1992 and was installed on the NGL pumps and associated piping. It provides Painter personnel with the current and historical information they need on these machines. If they see vibration levels beginning to increase, personnel can be sent out to determine if pipe clamping

1993 Savings in Repair Costs

Date	Equipment Description	Problem	Replacement Cost	Repair Cost	Savings
Ap. 93	Semi-Lean pump	Thrust bearing failure	$30,000	$2,100	$27,900
Aug. 93	Electric lean booster	Electric motor failure	$14,000	$14,000	0
Aug. 93	Combustion Air Blower	Excessive clearance in rotor	$51,000	0	$51,000
Aug. 93	Hot glycol pump	Outboard bearing failure	$8,000	$550	$7,450
Aug. 93	Lean amine pump	Pump failed internally	$43,000	$25,000	$18,000
Nov. 93	H.P. lean amine turbine	Bearing failure	$12,000	$850	$11,150
	Hydrocarbon Recovery Unit expander	Detected a rub in an early stage	$450,000	$250,000	$200,000 plus 7 days lost production
	Restock of hydrocarbon Recovery Unit Expander Parts		$200,000	$21,000	$179,000
Nov. 93	Lean booster pump	Cavitation problems	$14,000	$5,000	$9,000
Totals			**$822,000**	**$318,500**	**$503,500 plus seven days lost production**

Table 1
Whitney Canyon Gas Plant documented machinery repair cost savings from Trendmaster®2000 from April to October 1993.

is loosening. Implementing these solutions has helped Painter personnel reduce the frequency of maintenance from 2-3 times per week to 1-2 times a year.

In the future, Painter plans to use Trendmaster 2000 to monitor expanders and other problem machines. In addition, more personnel will be trained on the system to increase knowledge and skill levels. Mike Johnson, Production Foreman, sees the Trendmaster 2000 as being a focal point in Painter's current maintenance program.

Anschutz Ranch East

Amoco Production's Anschutz Ranch East (ARE) Gas Processing Plant is located 16 miles (26 km) southwest of Evanston. The gas field was discovered in 1979, plant construction began in 1986 and was completed in July 1987. Average daily throughput at this plant is approximately 600 million cubic feet (17 million cubic meters) of gas, 10,000 barrels of condensate and 20,000 barrels of natural gas liquids. This makes the Anschutz Ranch East Plant the largest of the three gas processing plants. ARE is one of the largest gas processing plants in the U.S.

Bill Hendricks, ARE Senior Maintenance Foreman, listed two main reasons why ARE went with an on-line Trendmaster 2000 System for their machinery data collection. The first is that, although ARE is the largest of the Evanston operation plants, it does not have as much spare equipment as the other two plants. Bill states, "Since we don't have as much spare equipment, we have to be proactive about maintenance."

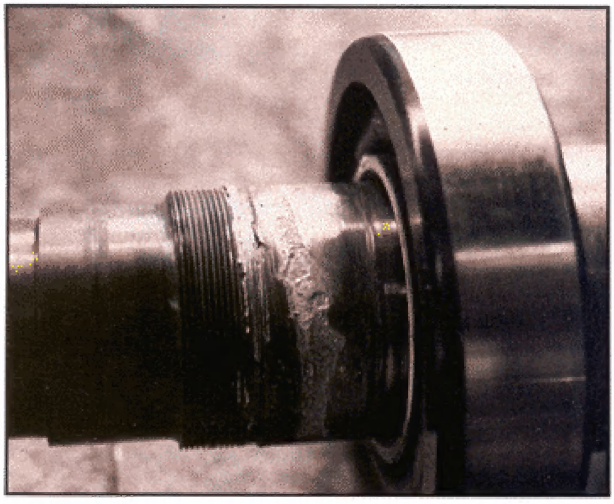
The second reason is that, although the portable data collection program at ARE was successful, it was manpower-intensive and the information was collected on a weekly basis. His vibration analysts were spending most of their time collecting data. They didn't have the time to sit down, analyze the information and develop proactive solutions to the problems. Using on-line data collection system, analysts can now devote more time developing proactive solutions to problems.

ARE decided that the first step in their proactive maintenance program was to put all essential machines, such as expanders and compressors, on the Trendmaster 2000 System. If these machines go down, production is affected. A 70-point Trendmaster 2000 System was ordered in Fall 1993 to accomplish this. Three York centrifugal compressors were already being continuously monitored using Bently Nevada 7200 Monitors. The buffered signals from the 7200 Monitors will be wired into Trendmaster 2000 Rack Buffered Output TIMs. This will provide the plant with automatic data collection, trending and alarming, along with the tools to diagnose data.

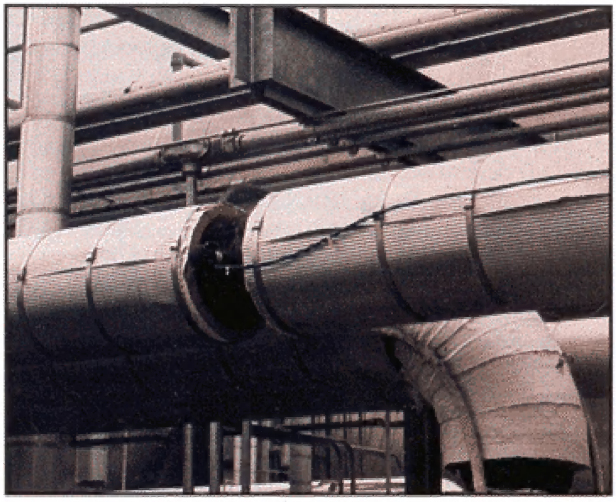
Anschutz Ranch East is aware of the expansion capabilities of the Trendmaster 2000. Initial system installation plans are taking into account the long-term goal of putting most of the plant's machines on the system. System cable routing will be strategically laid out to accommodate quick and easy expansion later. Information from the system will be available to both maintenance and operations personnel, so they can make informed process decisions.

Conclusion

All three of Amoco Production Company's Evanston facilities use Trendmaster 2000 as a component of their maintenance management systems. Instead of spending time walking around collecting data, information is available at the Host Computer. This cuts the workload so mechanics can devote their time to troublesome pieces of equipment and machinery analysts can spend more time anticipating or diagnosing problems. Trendmaster 2000 enabled Amoco's facilities to move from a reactive mode to a proactive role and to save substantial repair costs in 1993.■



Trendmaster®2000 helped inform Amoco of this machinery problem before the equipment failed.



Trendmaster®2000's flexibility helps Anschutz Ranch East determine the severity of piping vibration.